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Novel Electric Drive Solution for Tidal Power Generation using 5-level NPC converters

Background and Aim

Tidal energy offers many advantages compared to other renewable energy sources, such as having predictable and reliable power generation and robust nature against climatic changes, since it is not dependent on the wind volatility, rain, snow, clouds and fog. However, the problem of transferring the generated power to the shore in an efficient way is an important issue that needs to be addressed. The increase of the operating voltage of the power generation system using multilevel power converters is an effective way of solving this problem. The aim of this work is to present an optimized drive system using 5-level neutral-point-clamped (NPC) converters that can be used in a tidal power generation system.

Modeling of the Power Generation System

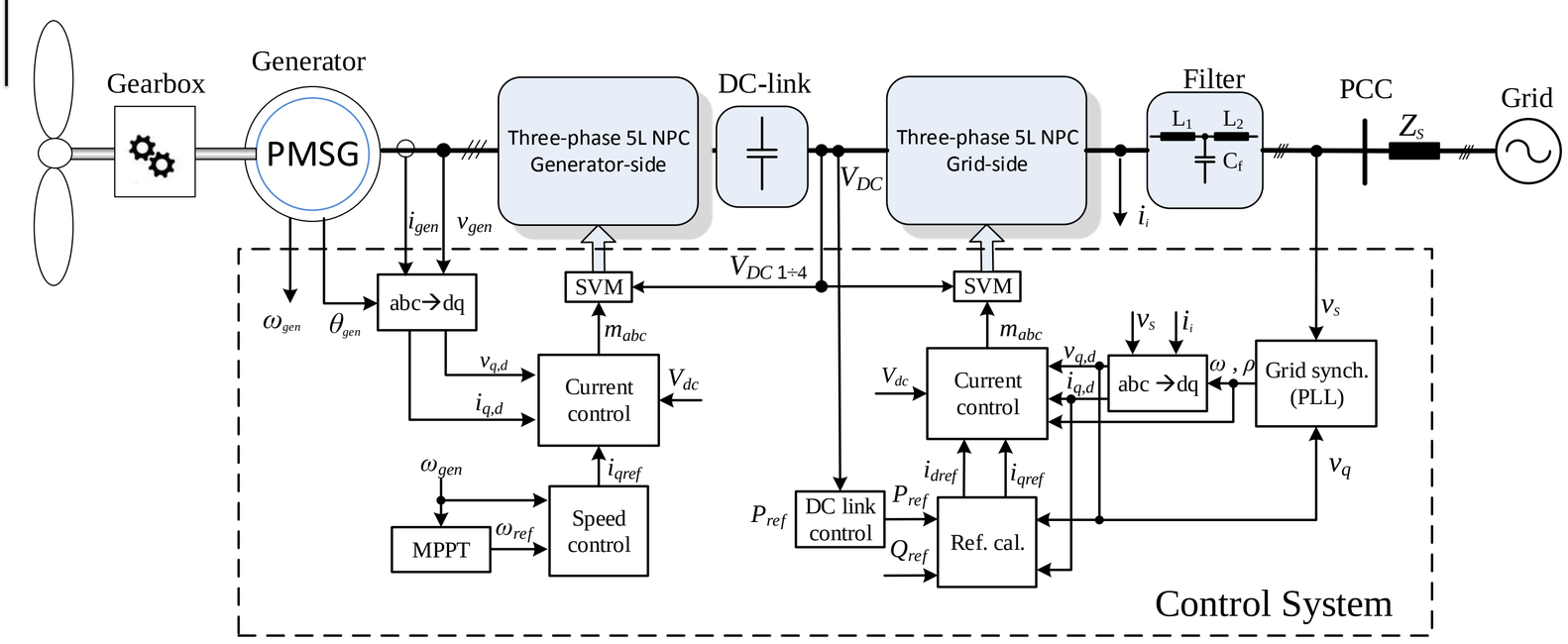

Fig. 1 Structure of the proposed tidal generation system with two NPC converters

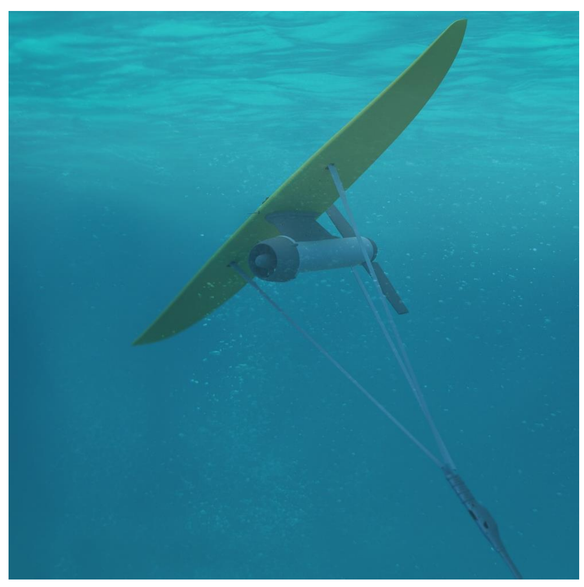

Fig. 2 Overview of the tidal power-take-off (PTO) system.

Simulation results

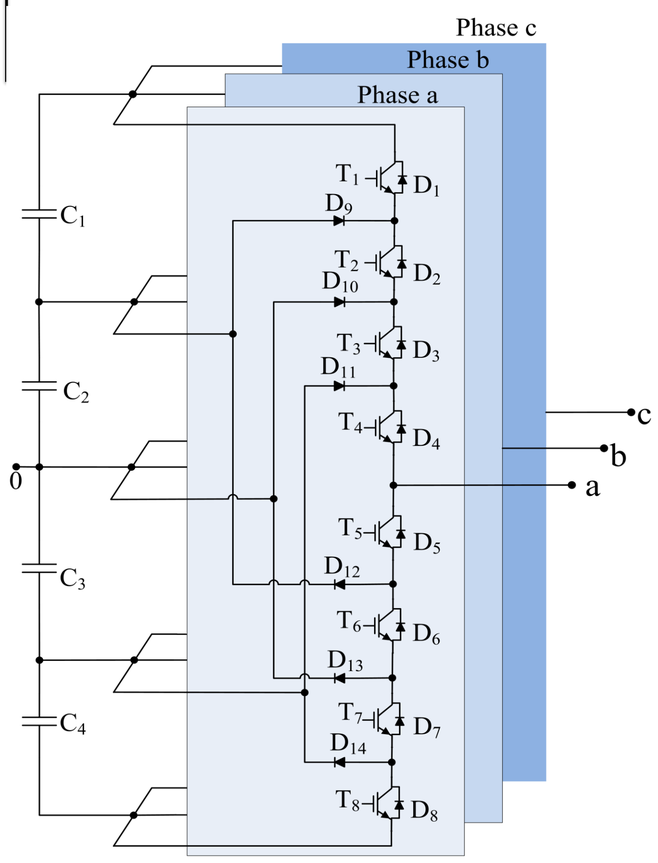

Fig. 3 Circuit diagram of a 3-phase 5-level NPC converter

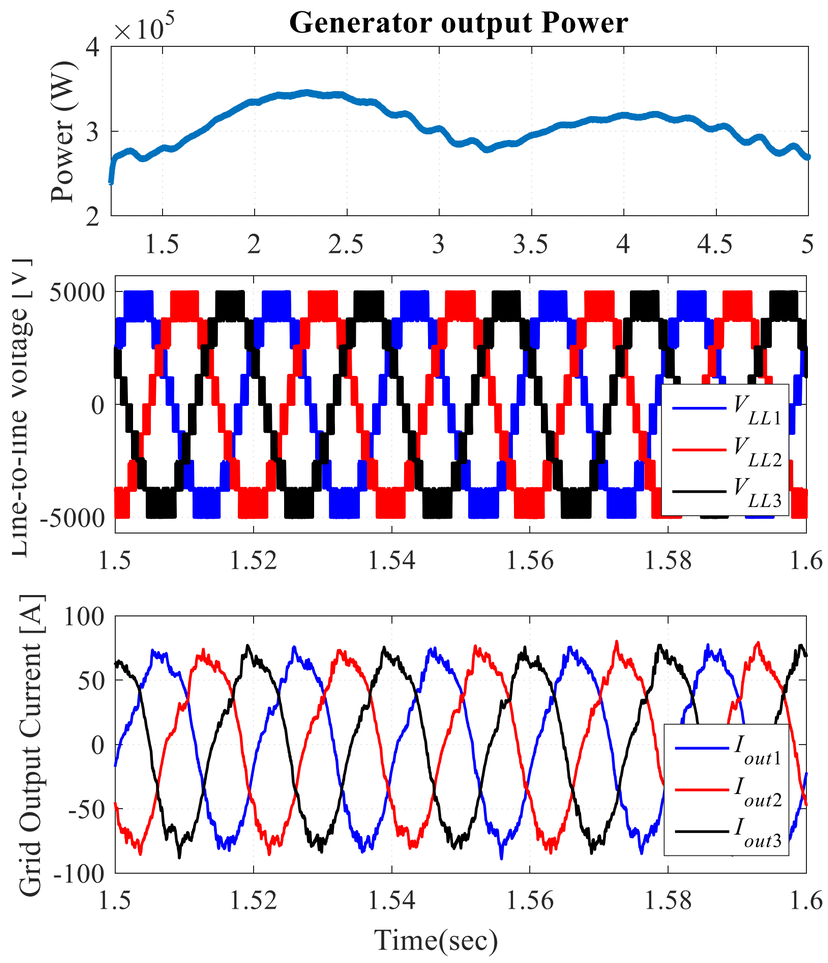

Fig. 4 Simulation results of the produced generator power and the NPC converter system at the connection to the grid

- **The output line-to-line voltage at the point of common coupling with the grid consists of five levels. Therefore, a smaller passive filter can be designed at the output of the topology compared to the 2-level converter topologies.**
- **The rms value of the line-to-line voltage V_{LL} at the connection to the grid is 3.3 kV.**
- **The power produced by the tidal generator is not constant, but changes periodically over time.**
- **The developed control system of the electric drive adjusts to the variating power and remains stable during the whole operation.**

Conclusions

- **NPC converters can increase the power density of the electric drive that controls the generator by increasing the operating voltage. As a result, the weight and volume of the underwater cables connecting the PTO with the shore can be decreased.**
- **The multilevel converter topology increases the power quality of the voltage at the point of common coupling with the grid. Therefore, the smaller and more compact passive filters can be used for bringing the THD at acceptable levels.**
- **The feasibility of the proposed power generation system for offshore tidal power plants using 5-level NPC converters has been evaluated through simulation results.**
- **The developed control system of the NPC converters attains stable performance of the whole tidal power system.**

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